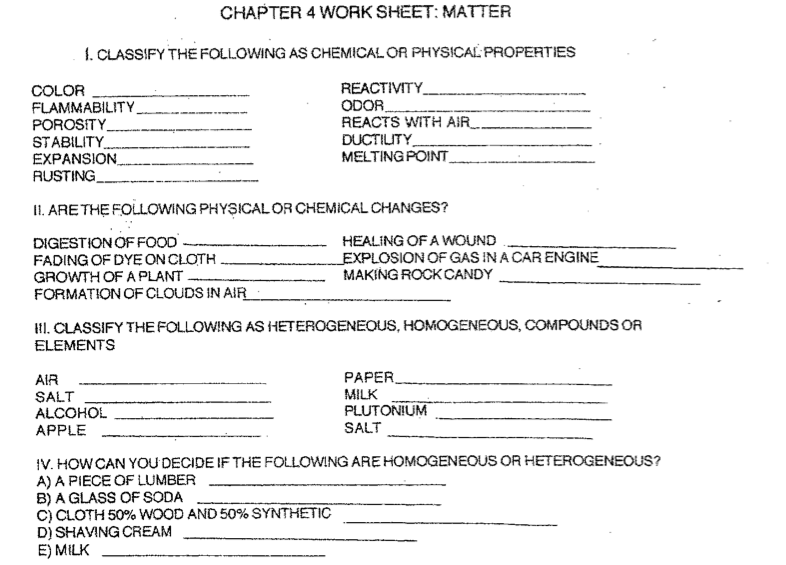
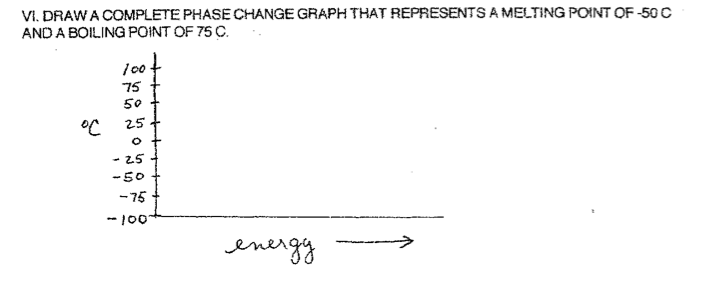
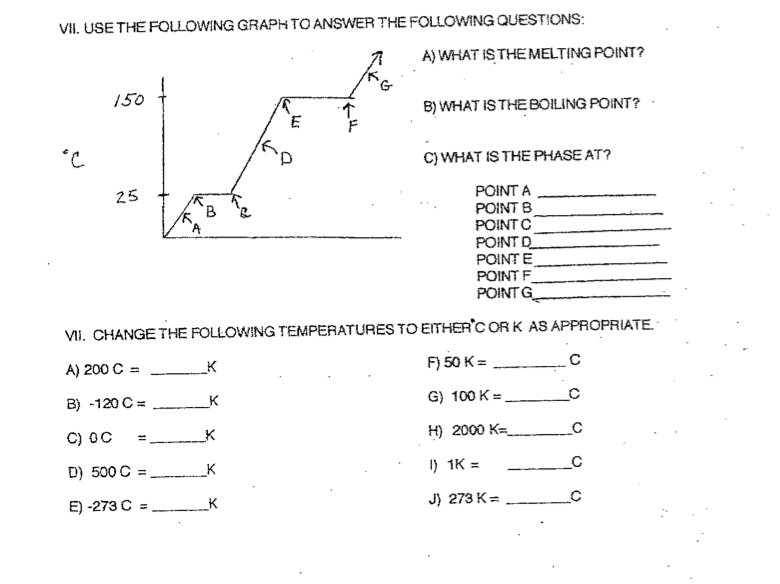
HW#2 Matter, Phase Changes, Heat

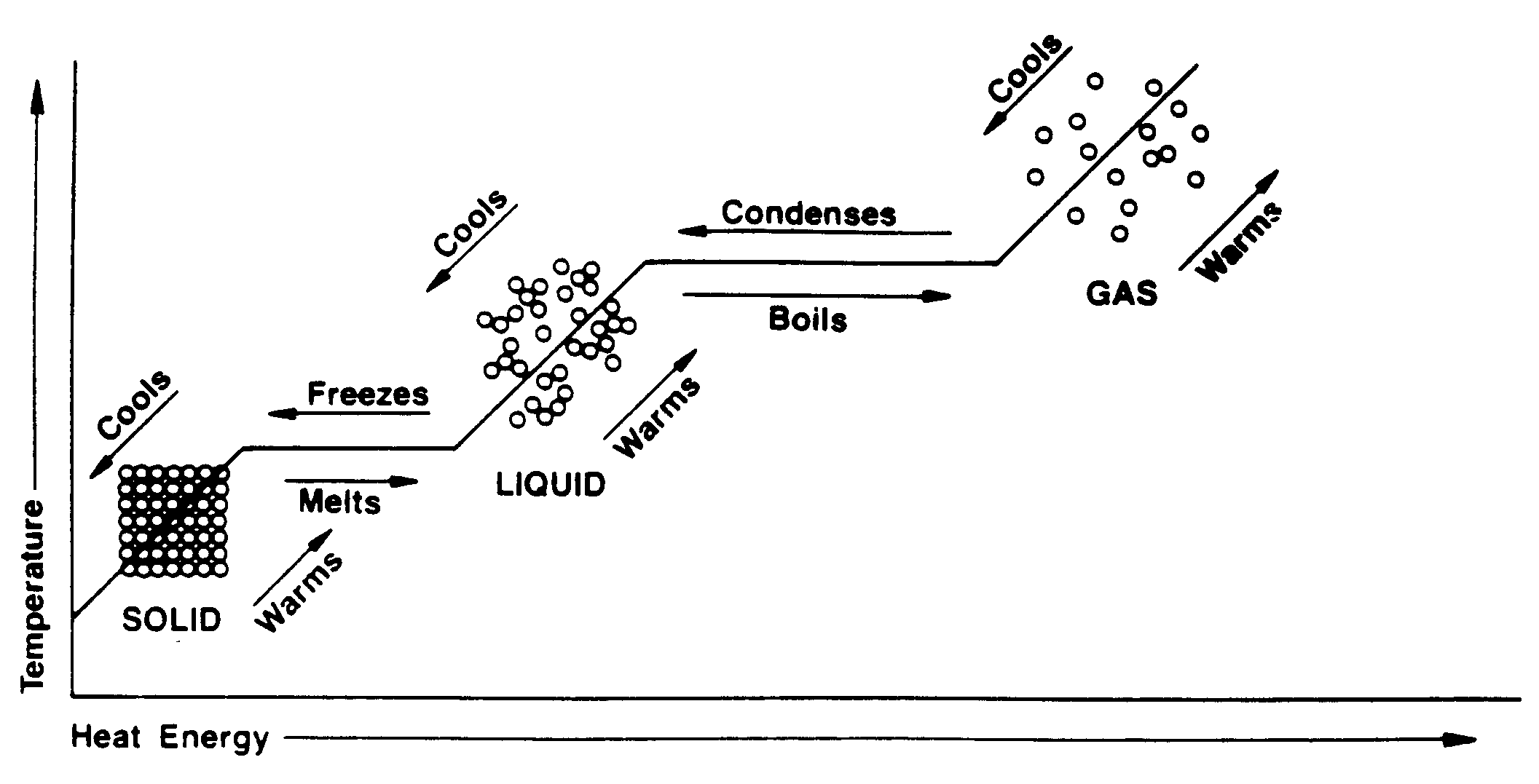






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Observing Phase Changes

The graph below shows the relationship between temperature andheat energy during the phase changes of water. Study the graph and answer the following questions. 

1. Does the temperature increase during melting? State how you know. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Is energy required during the phase change? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

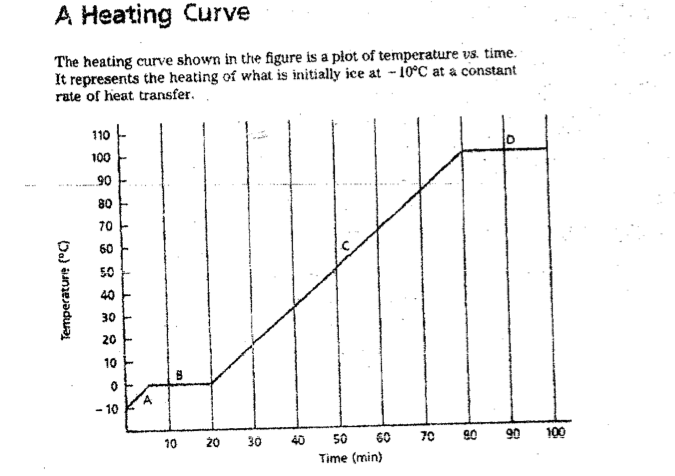
3. Can both liquid water and steam exist at 100C?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

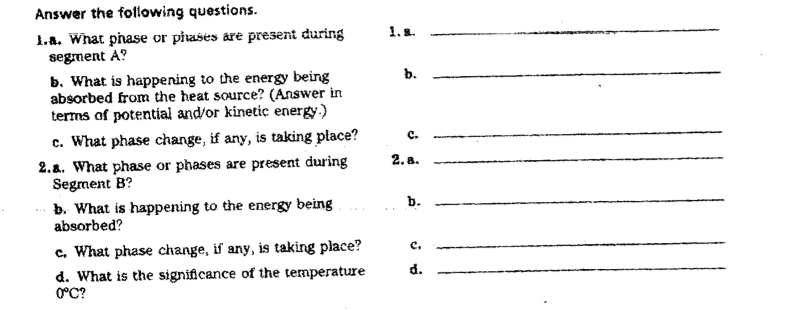
4. What must be changed—Temperature or Heat Energy—during condensation? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

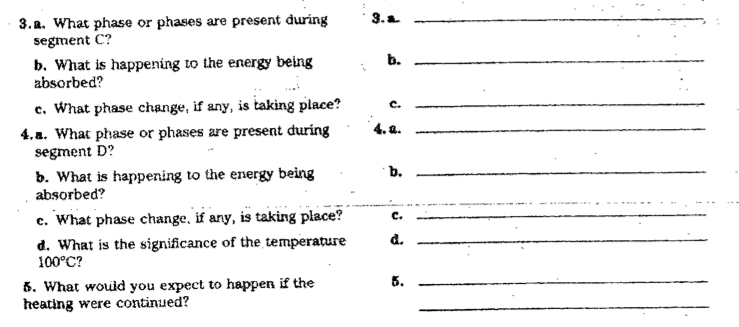
5. How would you describe the change in the arrangement of particles as heat energy and temperature increase? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. What relationship do you see between phase changes and temperature? Between phase changes and heat energy?

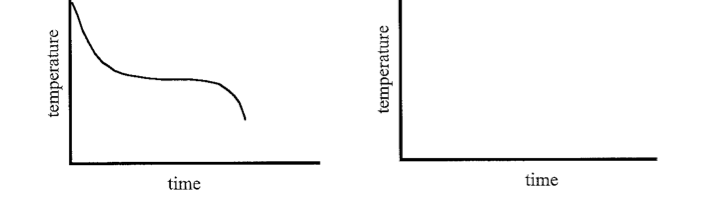
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_







1.The graph below left shows the cooling curve for a substance as it freezes.



a. On the graph at right sketch the cooling curve for a **larger** sample of the same substance above.

b. Label which phase (or phases) of the substance is present in each of the three portions of the cooling curve. Identify kinetic vs potential areas.

c. Describe the arrangement and motion of the molecules during each portion of the graph. Draw particle arrangements for each of the phases.

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2.During boiling, bubbles appear in the liquid water. In the boxes below represent the arrangement of molecules inside the liquid water and inside a bubble.

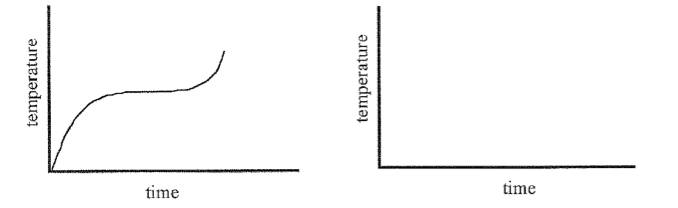
liquid water bubble

|  |  |
| --- | --- |
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What is inside the bubble? Why do you think so?

5. Suppose the burner under the pan of boiling water is turned to a higher setting. How will this affect the temperature of the water in the pan? Explain.

6. The graph below left represents the heating curve for a liquid heated from room temperature to a temperature above its boiling point.



a. Sketch the heating curve for a **larger** sample of the same liquid above.

b. Label which phase (or phases) of the substance is present in each of the three portions of the heating curve.

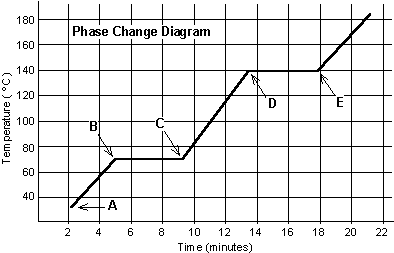
c. Describe the arrangement and motion of the molecules during each portion of the graph. Draw particle arrangements for each of the portions on the graph.

|  |  |  |
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Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Heating Curves:**

The following graph represents a temperature vs time phase change graph.



1. What phase or phases are present between A and B? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. What is happening to the energy being absorbed from the heat source? (answer in terms of PE or KE)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. What phase change is taking place between A and B?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. What phase or phases are present during segment BC?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. What is happening to the energy being absorbed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. What phase change, if any, is taking place? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. What is the significance of the temperature 70C? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. What phase or phases are present between C and D?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9.What is happening to the energy being absorbed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. Is there a phase change occurring ? which one? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11. What phase(s) are present after E?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12. What is happening to the energy being absorbed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13. What phase change, if any, is taking place? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14. What is the significance of the temperature 140C? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

15. What would you expect to happen if the heating continues? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Chemistry Lab #2 – Melting Point/Freezing Point of a Pure Substance

Procedure:

Part 1:

Obtain a test tube of stearic acid with a thermometer already in it. Heat a beaker of water up to 70 degrees Celsius with a hot plate. When the water is heated, place the test tube in the beaker and secure the test tube with a buret clamp and ring stand. Record the temperature of the stearic acid every 30 seconds until the stearic acid is completely melted. Plot the points on a graph to create a graph titled “Solid to Liquid.”

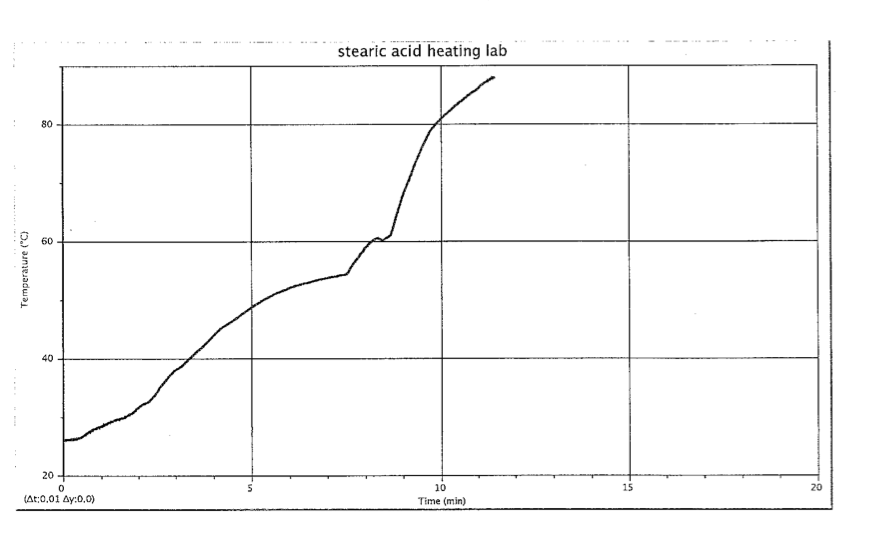
Part 2:

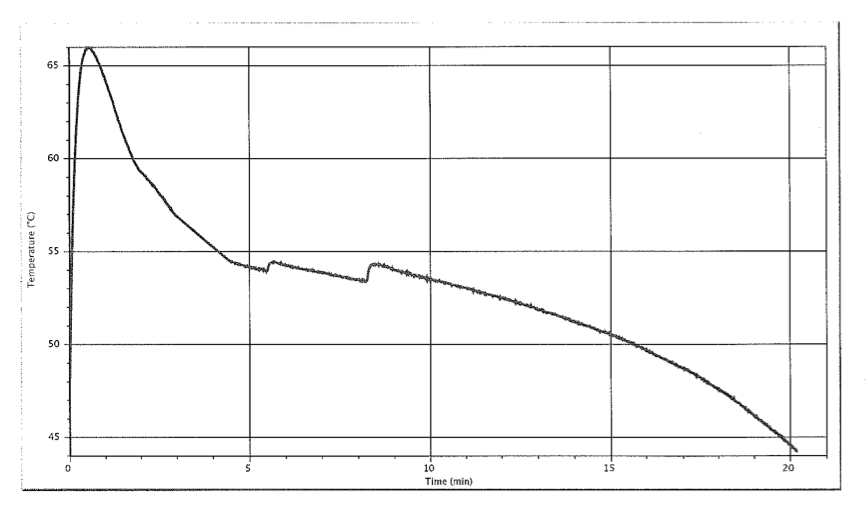
Take a test tube filled with melted stearic acid. Remove it from the hot water bath. The test tube should remain attached to the buret clamp on the ring stand. Place the thermometer into the test tube. Start recording the temperature when the stearic acid has reached 70 degrees Celsius. Record the temperature every 30 seconds. Plot to the points on a graph to create a graph titled “Liquid to Solid.”

Make sure to put everything back where you got it. Clean up after you are done the lab. If you are unsure of what to do at any point, ask the teacher.

Discussion Questions

1. Based on your observations, what is the melting point of stearic acid? What is the freezing point of stearic acid?
2. Describe the shape of the two graphs. What do you think is happening during the time where the flat spot occurs?
3. Is energy still being transferred to the stearic acid during the flat spots in the graph? If so, what is that energy doing?
4. What would a complete temperature vs time graph look like for stearic acid if it were done perfectly? (Start as a solid.)





Specific Heat Problems

1. How much heat would be needed to raise the temperature of 100 ml of water from 20°C to 80°C?

2. If 20,900 J of heat energy is added to a 70 g piece of steel at 20°C, what is the final temperature? The SHC (Cp) of steel is 0.418 J/g°C.

3. If 4,180 J of heat energy raises the temperature of a piece of aluminum with SHC (Cp) of 0.8778 J/g°C from 0°c to 45°C, what is the mass of the aluminum?

4. If 41,800 J of heat energy is added to 500 ml of water at 20°C, what is the final temperature?

5. If 20,900 J of heat energy raises the temperature of 200 g of an unknown substance from 20°C to 90°C, what is the specific heat capacity of the metal?

6. How much heat would be required to heat 390 **kg** of nickel from 25°C to 300°C? The Cp of Ni is 0.443 J/g°C.

7. How much heat would be required to heat 54.4 g of tin from 24°C to 100°C? The Cp of Sn is 0.220 J/g°C.

8. If a piece of cobalt with a mass of 25.2 g and a temperature of 100°C is dropped in 15 cm3 of water at 22°C, what will be the final temperature of the system? The Cp of Co is 0.446 J/g°C. \*\*\*\*

9. If a piece of unknown metal with a mass of 32.2 g is heated to 100°C and dropped in 60 ml of water at 25°C, what is the specific heat capacity of the metal if the final temperature of the system is 35.2°C?

10. Calculate the energy needed to raise 30 g of ice from -10°C to 125°C.

HEAT WORKSHEET#2

1. 2700 cal of heat energy is added to 200 ml of acetone that has a temperature of 20°C. What is the final temperature? (Acetone has a density of 0.79 g/ml and a specific heat capacity of 0.52 cal/g°C).

2. How much heat is required to raise the temperature of one liter of water from 20°C to 25°C?

3. Steel has a specific heat capacity of 0.107 cal/g°C while aluminum’s is 0.21 cal/g°C. If you had two pots of equal mass, 1.5 kg, which pot would take more heat to heat up AND how much more heat would it take to heat the one pot from 20°C to 220°C?

4. The melting point of brass is 900°C. How much heat would be needed to get 800 g of brass from 20°C to the melting point? (Specific heat capacity of brass is 0.092 cal/g°C)

5. 2600 cal of heat energy is added to a piece of copper at 27°C. The temperature rises to 53°C. What is the mass of the copper? (Specific heat of copper is 0.091 cal/g°C)

HEAT PROBLEMS CONT’D

1. How much heat would be needed to take 500 g of steel from -20°C to 75°C? (Specific heat capacity of steel is 0.11 cal/g°C)

2. If you add 50,000 cal to 80 g of water at -75°C, what will the final temperature and state be of water?

3. 500 cal of heat causes a piece of aluminum to go from 20°C to 55°C. What is the mass of the Al? (Specific heat capacity is .21 cal/g°C)

4. 250 g of an unknown metal at 100°C is placed in 150 ml of water that is at 20°C. When equilibrium is reached, the temperature is 23°C. What is the specific heat capacity of the metal?

5. 2000 cal of heat is added to 90 g of brass at 20°C. What is the final temperature of the brass? (Specific heat capacity is .092 cal/g°C)

6. How much heat would be needed to take 100 g of ice at -58°C to liquid water at 46°C?

More chemistry heat problems

1. How much heat would be needed to raise the temperature of one **liter** of water from its freezing point to its boiling point?
2. A 50 g piece of steel has 1500 cal of heat energy added to it. If the specific heat capacity of steel is 0.448 J/g°C and the original temperature is 20 °C, what is the final temperature? (1 cal = 4.184 J)
3. 2000 Joules is added to a piece of steel and the temperature goes from 20 °C to 500 °C. What is the mass of the steel? Same specific heat capacity value as the last problem.
4. Define specific heat capacity and calorie.
5. 5000 cal of heat energy is added to a 300g piece of aluminum, (specific heat capacity 0.21cal/g°C), that has a temperature of 20 °C. What is the final temperature of the aluminum?
6. How much heat would be needed to change 50g of ice at -40°C to liquid water at 20°C? (specific heat capacity of ice is .5cal/g°C)(Heat of fusion of water is 80cal/g)
7. How much heat would be needed to melt 100g of ice at its melting point?
8. Draw a melting point curve and label the different sections.
9. Describe what occurs during a phase change.
10. What is the melting point of water? What is the freezing point?

Chemistry Practice problems Heat Equilibrium

1. A 110 g piece of steel at 20°C is placed in 200 ml of water at 100°C. What is the final temperature of the metal and water? (SHC steel use .107 cal/g°C)
2. A student heats a 150g piece of aluminum to 1350°C and then places it in cool 20°C water to cool it off. If the student uses 100 ml of water, will it still be too hot to touch? (SHC aluminum use .84 J/g°C)
3. How much 20°C water would be needed to cool a 1 **Kg** horseshoe from 1750°C to 50°C so that it can be picked up without burning the user? (SHC of metal shoe is .11cal/g°C)
4. Describe how you would measure the specific heat capacity of an unknown metal.
5. A 250 g piece of unknown metal at 100°C is placed in 150 ml of water at 25°C. The equilibrium temperature is 29.3°C. What is the specific heat capacity of the metal?

